University Technology Transfer Offices: A Status Report

Peter M. Fleischut and Scott Haas
Department of Health Policy,
Jefferson Medical College

Universities are committed to biotechnology research, and they make this commitment operational, in part, through the activities known as "technology transfer." The growth of technology transfer has fostered examination of the impact of academic research on industry. This growth is largely attributable to the enactment of the Bayh-Dole Act of 1980, which allows federally funded research to be patented.

Within the industry, various definitions of the process of technology transfer have been used. According to the Association of University Technology Managers (AUTM), it is "the formal transfer of new discoveries and innovations resulting from scientific research conducted at universities and nonprofit research institutions to the commercial sector for public benefit" (Crowell 2005).

Author correspondence:

Peter M. Fleischut
Jefferson Medical College
1025 Spruce Street
Philadelphia, PA 19107
Phone: (302) 354-1324
Fax: (215) 923-9383
Email:
Peter.Fleischut@Jefferson.edu

TECH TRANSFER OVERVIEW

The many different interpretations of defining technology transfer create an environment for multiple organizational strategies. Typically the process of technology transfer remains the same from institution to institution. It begins with federal funds that are used for the purposes of research and development (R&D), which eventually turns into intellectual property and then results in prototypes, products, and commercialization. The flow of these activities is a simplified version of what actually occurs; there may be different variations of this process depending on what technology is being transferred.

Peter M. Fleischut

Scott Haas

As technology transfer starts with federally funded R&D, it is important to understand exactly where the funding is coming from and where it is going. The major contributors of federal funding are the Department of Defense, the Department of Health and Human Services, the National Aeronautics and Space Administration (NASA), the Department of Energy, and the National Science Foundation. In 2002, these R&D supporters, along with other organizations, distributed $80.6 billion. The organizations receiving these funds comprised businesses, federal laboratories, colleges, and universities. Businesses were responsible for about 38 percent of these funds. Federal laboratories received approximately 30 percent of the funds, and colleges and universities accounted for 25 percent (Wang 2003).

Given that different government organizations are responsible for different R&D performers, it is important to know which organizations fund which performers. Sixty-five percent of college and university funding is from the Department of Health and Human Services, followed by the National Science Foundation, the Department of Defense, and other organizations (Wang 2003). This differs greatly from funding for business and federal laboratories, which is primarily from the Department of Defense.

R&D institutions can produce multiple types of research, but some are more prepared for technology transfer than others. Research can be divided into three categories: basic, applied, and developmental. Applied research and nondefense developmental research carry the highest likelihood of technology transfer. Currently, 40 percent of R&D funding is used for applied research, 30 percent is used for basic research, and 30 percent is used for developmental research. The Department of Health and Human Services funds applied and basic research equally. Life sciences research dominates the applied research discipline (Wang 2003) and is a major contributor to technology transfer.

UNIVERSITY OFFICES AND LICENSING

Fully understanding technology transfer also involves comprehending the organization and goals of university offices. There are many different strategies used for organizing technology transfer offices. Bercovitz (2001) outlined how organizational form-information processing capacity, coordination capability, and incentive alignment relate to technology transfer outcomes. Outcomes are being measured in terms of patenting, licensing, and other research activities. These data suggest that different organizational strategies yield different outcomes.

Other surveys have been conducted in part to summarize the goals of technology transfer offices. Survey results from Thursby (2000) indicate that the most important objective for technology transfer offices is to generate royalties and fees. Writing in the *Philadelphia Business Journal*, Anil Rastogi, PhD, who directs Drexel University's technology transfer operations, recently positioned his own role as one to help the institution and the inventors commercialize their technology in the most effective way and create a situation where all stakeholders feel that they get something from it (Key 2004). Nevertheless, in light of the goal of universities to contribute to development, technology transfer offices also consider initiation of sponsored research and creation of licenses and marketed inventions as goals, independent of the monetary returns (Thursby 2000).

Once a new product is in development at an academic institution, work begins on obtaining a license. It is crucial for the inventor to remain actively involved in the process of finding licenses, as well as in further development after a license has been executed. Interestingly, most inventions are licensed when they are still in the early stages of development. Licensing products earlier in their development has the effect of decreasing royalties but increasing the likelihood of more sponsored research (Thursby 2000).

Because the university usually maintains ownership of new inventions, the administration must distribute the revenue generated from those products among various parties. The majority of the funds are distributed between the university, the technology transfer office, the inventor, and the inventor's department. There is some variability in the proportion that each group receives, however, based on the individual university and whether the product is a patented invention or copyrighted material (Thursby 2000).

MEASUREMENT OF TECH TRANSFER OFFICES

Measuring outcomes of the activities of technology transfer offices remains a challenging task (Wang 2003). One extremely useful source of data is the AUTM licensing survey, which measures licensing activities from United States and Canadian universities, hospitals, and research institutions. The latest survey completed by the AUTM was compiled from fiscal year 2002 data (all years cited from the AUTM survey correspond with fiscal years).

In 2002, the AUTM surveyed 364 institutions, up from 335 institutions in 2001. In 2002, 222 institutions (61 percent) responded to the survey — a 12.1 percent increase in the number of respondents over the previous year. Among respondents in 2002, 156 were universities, up from 142 in 2001; 32 were hospitals and research institutes in the United States, an increase from 28 in 2001, and 33 were Canadian institutions, six more than in 2001. In addition, a single third-party patent management and investment company responded to the survey, unchanged from the previous survey (AUTM 2003).

According to the AUTM Message From the President [Patricia Harsche Weeks]:

With 222 respondents, the *AUTM FY 2002 Licensing Survey* collected data from more organizations than ever before — 24 more institutions than last year. These organizations reported that:

- 569 new commercial products were launched, bringing the total number of new products introduced into the marketplace since 1998 to well over 2,000
- 450 new companies were established in 2002, for a total of 4,320 since 1980
- 2,741 of those start-ups were still operating at the end of 2002

- Running royalties on product sales were $1.005 billion, representing an 18.9 percent increase over 2001
- New licenses and options executed in 2002 increased 15.2 percent from 2001; this reversed a drop in this activity from 2000 to 2001

RESEARCH EXPENDITURES

In measuring the effectiveness of technology transfer offices, it is important to calculate the expenditures for research. Any correlations between research expenditure and an increase or decrease in productivity should be identified.

One challenge to looking at these data is that the respondent rate has increased through the years, making it important to document the respondent rate with each value observed. To account for this, AUTM has based its year-to-year changes on institutions that have responded to both the 2001 and 2002 surveys.

According to the *AUTM FY 2002 Licensing Survey*, 212 institutions reported the total sponsored research expenditures. These expenditures increased by 16.6 percent from 2001, when 194 institutions responded to the survey (Figure 1). Figure 1 also shows that the majority of total sponsored research expenditures are funding institutions with an affiliated medical school.

Overall, there has been a substantial increase in government funding of research that can be traced to the National Institutes of Health and the National Science Foundation. Both the NIH and the NSF currently are in various stages of 5-year programs to double their funding for such activity (AUTM 2003).

PATENT-RELATED ACTIVITY

Another important component to researching success of technology transfer offices is to monitor their invention disclosures, new patent applications, and the number of patents that have been issued.

According to the *AUTM FY 2002 Licensing Survey*, the number of invention disclosures and new patent applications filed in fiscal year 2002 increased 14.8 percent and 13.6 percent respectively (Figure 2). The increased number of patent applications is most likely a result of the rise in invention disclosures. An invention disclosure may result in one or more patent applications being filed within that year or in the following year. Also, multiple invention disclosures may be combined into one patent application.

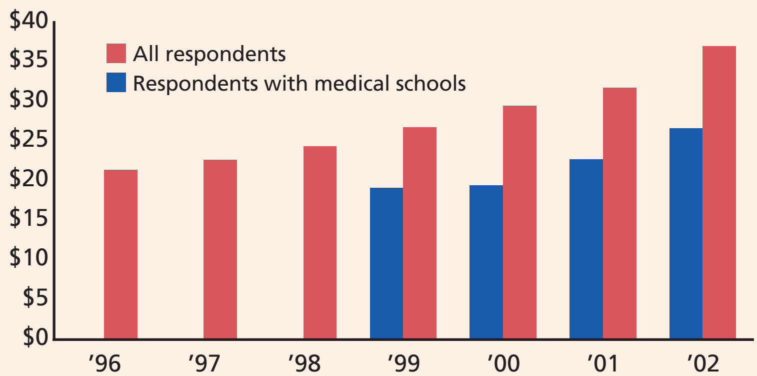
The number of patents issued in 2002 decreased 1.3 percent over 2001. The number of patents being issued has not increased at the same rate as the patent applications, although there have been 28,093 total U.S. patents issued since 1993 (AUTM 2003). As seen in Figure 2, most patent-related activity occurs at institutions with an affiliated medical school.

LICENSES AND OPTIONS

The *AUTM FY 2002 Licensing Survey* also collected information on licenses and options, which is another way of monitoring the success of technology transfer offices. As shown in Figure 3, the total number of active licenses and options increased 13.7 percent when compared to 2001. According to AUTM, running royalties on product sales were collected from 22.4 percent of these active licenses and options. Interestingly, AUTM calculated exclusivity for licenses and options; 96.5 percent of the total reported licenses and options executed were categorized according to their exclusivity. In 2002, 46.5 percent of new licenses and options executed were exclusive, compared with 48 percent in 2001.

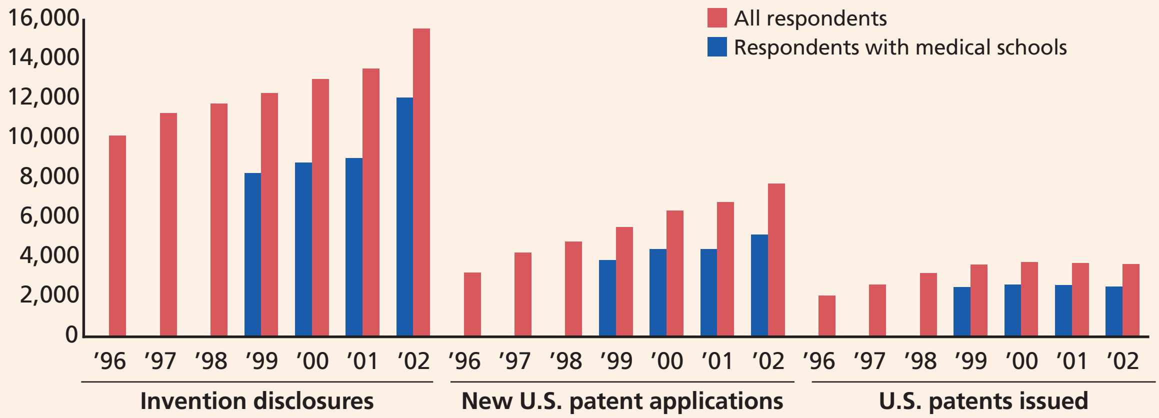
According to AUTM, 68.2 percent of new licenses and options executed were with companies with fewer than 500 employees, and 31.8 percent were with large companies. Of the licenses and options to start-ups, existing small companies, and large entities,

FIGURE 1 Total sponsored research expenditures
In billions



SOURCE FOR ALL FIGURES (1–6): AUTM 2003

FIGURE 2 Patent-related activity
Number of invention disclosures, new U.S. patent applications, and U.S. patents issued, by year



91 percent, 45.4 percent, and 38.7 percent, respectively, were exclusive (AUTM 2003). Once again, the majority of active licenses and options originated from institutions with an affiliated medical school (Figure 3).

LICENSE INCOME

Licensing income has become widely used as a tool of measuring technology transfer offices. Figure 4 shows that the number of licenses that have been yielding income has increased since 1996. In 2002, 218 institutions reported 10,866 licenses and options yielding income — an 11.9 percent increase compared to 2001. Licenses and options that generated running royalties on product sales were up 15.1 percent from 2001. Figure 5 (page 52) shows that the gross license income received from licenses and options reported in 2002 was up 18.3 percent from 2001. Finally, the running royalties on product sales in 2002 were up 18.9 percent from 2001. The majority of license and options income has been going to institutions with an affiliated medical school.

All of these data reflect a consis-

FIGURE 3 Active licenses and options
Number of licenses and options

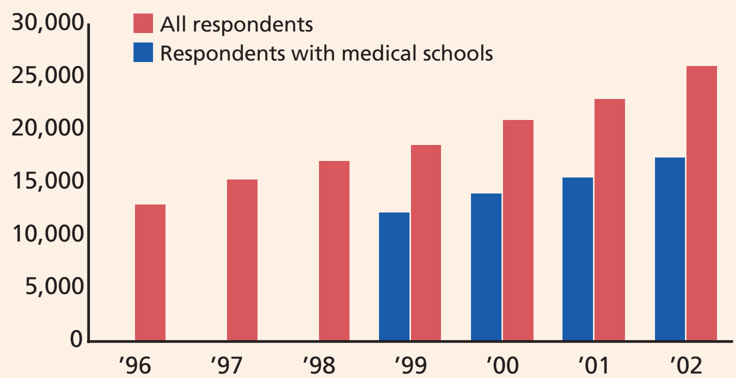


FIGURE 4 Licenses/options yielding income
Number of licenses and options

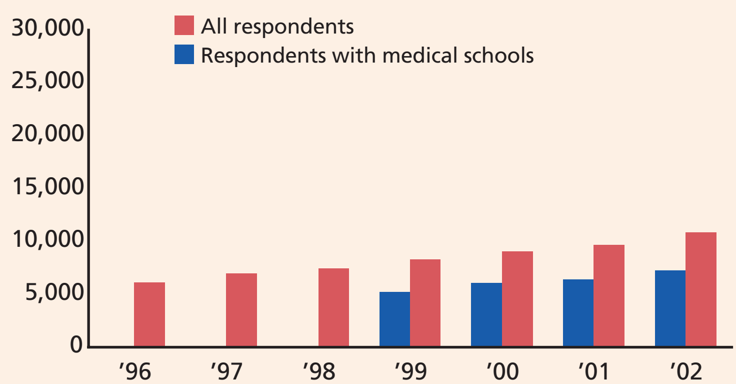


FIGURE 5 **Gross license income received**
In billions ($)

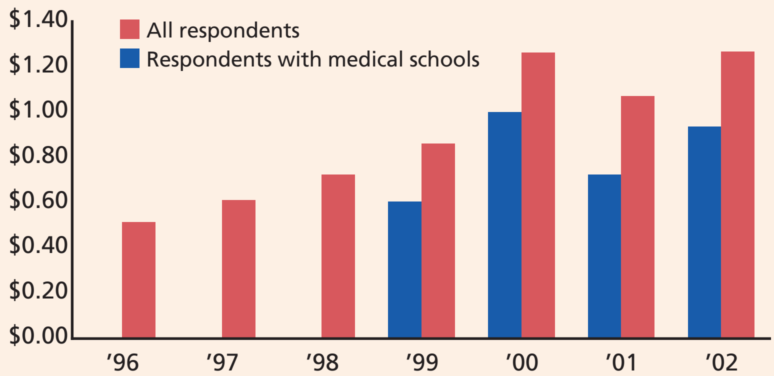
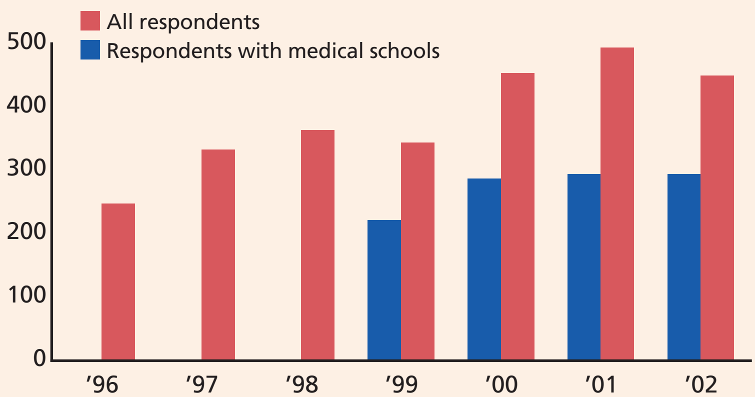


FIGURE 6 **Start-up activity based on academic discoveries**
Number of new companies



tent increase in outcomes from technology transfer offices — ranging from licenses and options to their respective income (AUTM 2003).

START-UP ACTIVITY

Start-up activity is another crucial component to evaluating technology transfer offices because of the economic effect of such companies and their technological advances.

According to the *AUTM FY 2002 Licensing Survey*, the number of start-up companies decreased 8.9 percent from fiscal year 2001 but the overall start-up activity has been increasing consistently. Nevertheless, 2001 represented a significant increase in activity over 1996. Of new companies that started in 2002, the AUTM licensing survey stated, "83.1 percent were located in the state/province of the academic institution where the technology was created." Figure 6 shows that the majority of new companies have originated from an institution with an affiliated medical school. Since the passage of the Bayh-Dole Act, 4,320 new companies have been formed based on a license from an academic institution. Of these, 63 percent still were operating at the end of 2002 (AUTM 2003).

EFFECT ON INDUSTRY

As expected, surveys of R&D managers from many industries report various perceptions of how relevant university research is to each industry. Survey respondents from the biotech industry agree that university research has a crucial effect on industrial R&D. Industrial R&D labs now use developments that include techniques of recombinant DNA research, which originated at universities. Magnetic resonance imaging machines and other medical equipment resulting from university research demonstrate the capability of academic institutions to serve a problem-solving function for the biomedical industry (Cohen 1998). These applications support the finding that medical schools are a leading source of executed licenses (Thursby 2000).

The type of research also plays a part in determining the effect on industry. Studies have shown that this simple characteristic in itself correlates with differences in lag time between when research is being done and when a tangible or measurable result is seen commercially. The time span between research and result is approximately 20 years for research in the basic sciences, but only 0 to10 years for research in applied science and engineering (Cohen 1998).

CONCERNS

The growing ties between universities and industry have raised several concerns about possible adverse effects. These concerns stem from the fact that academia and industries have conflicting aspects to their cultures and missions (Gelijns 2002). University faculties conduct research not only to boost their incomes, but also to gain prestige. This recognition comes more from foundational research, which spawns many other projects, and is therefore cited often. Industry wants more applied research that leads to marketable products. Although the concern that efforts may be shifted away from basic research is certainly logical, it is not clearly supported by evidence. Some researchers, especially those who receive industry support, have reported that their project choices have been influenced by whether their efforts would yield a marketable product (Blumenthal 1996), but the overall makeup of academic R&D has remained relatively constant (Cohen 1998).

Another conflict in missions between universities and industries involves disclosure of information. A central theme of academic research is to assist the generation of new knowledge by freely sharing information.

To maintain proprietary control over the projects and ideas that they fund, industries favor less disclosure of information. Some evidence has shown that disclosure of information decreases when support for the research comes from industry. Official disclosure restrictions are imposed frequently, often for at least as long as it takes to file a patent application and, not uncommonly, for longer periods. Companies frequently request that publication of R&D results be delayed or withheld entirely; researchers often are restricted with respect to sharing information with colleagues, and they accept maintaining a more secretive environment (Cohen 1998, Blumenthal 1996).

Decreased disclosure of information can have a negative effect on the long-term progress of research. Data and techniques published in the literature are crucial for supplying investigators with ideas and methods that may be used to develop new projects. Thus, the reduction in academic paper productivity, resulting from restrictions on disclosure, can lead to a decrease in innovations in the long run. This long-term effect could counteract the short-term increases in technological advances yielded by industry-supported research. Academic papers in biotechnology seem to be an exception, however, as the number of these has not significantly declined (Cohen 1998).

One final concern involves the potential for economic incentives to cause universities to use overzealous tactics to maximize profits. In a recent *Wall Street Journal* article, Columbia University, which is ranked as the university with the largest amount of licensing revenue, is scrutinized for the aggressive legal practices it uses to extend its lucrative patents (Wysocki 2004). This continues the ongoing debate over academic values and whether these aggressive maneuvers are beneficial to technology transfer.

FUTURE DIRECTIONS

The challenge of maintaining productive university-industry relationships without sacrificing the quantity or overall progress of academic research needs to be addressed further. Several other topics for future research in technology transfer were discussed at a forum of the President's Council of Advisors on Science and Technology in December 2002 (Wang 2003). It was recommended that courses and training tools on technology transfer be developed. To compare the success of technology transfer efforts and ascertain best practices, the most useful measures for evaluating how technology transfer is progressing must be determined. Valuable information could be gained from analyzing the procedures of technology transfer in foreign countries (Wang 2003). The role that technology transfer offices will play in these future efforts remains to be seen. **BH**

REFERENCES

AUTM (Association of University Technology Managers). *AUTM Licensing Survey, FY 2002*. 2003: Northbrook, Ill.

Bercovitz J, Feldman M., Feller I., Burton R. Organizational structure as a determinant of academic patent and licensing behavior: an exploratory study of Duke, Johns Hopkins, and Pennsylvania State Universities. *J Tech Transfer.* 2001;26:21–35.

Blumenthal D, Campbell EG, Causino N, Seashore LK. Participation of life-science faculty in research relationships with industry. *N Engl J Med*. 1996;335:1734–1739.

Cohen W, Florida R, Randazzese L, Walsh J. Industry and the Academy: Uneasy Partners in the Cause of Technological Advance. In: Noll R, *Challenges to Research Universities*. Washington: Brookings Institution Press. 1998: 171–199.

Crowell M. Association of University Technology Managers (AUTM). Letter from the president-elect to members, 2005: Northbrook, Ill.

Gelijns AC, Thier SO. Medical innovation and institutional interdependence: rethinking university-industry connections. *JAMA*. 2002; 287(1):72–77.

Key P. Drexel Tech propels new companies. *Philadelphia Bus Journal*. 2004 April 23;23:10.

Thursby J, Jensen R, Thursby M. Objectives, characteristics, and outcomes of university licensing: a survey of major U.S. universities. *J Tech Transfer.* 2000;26:59–72.

Wang M, Pfleeger S, Adamson D. Technology transfer of federally funded R&D: perspectives from a forum. *RAND Sci Tech Policy Institute*. 2003;5–27.

Wysocki, B. Columbia's pursuit of patent riches angers companies. *Wall Street Journal*. Dec. 21, 2004;CCXLIV:121.